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ANALYSES OF THE PHYSICOCHEMICAL AND MICROBIOLOGICAL QUALITIES OF SELECTED SACHET WATER BRANDS IN ONITSHA, ANAMBRA STATE, NIGERIA

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ABSTRACT

This study analyzed the physicochemical and microbiological qualities of five sachet water brands that are mostly consumed in Onitsha. The researchers used respective meters for the physical parameters, an atomic absorption spectrophotometer machine for the heavy metal determinations and streak-plate method for the determination of microbiological parameters. The five sachet water brands that were used for the study were elicited from the respondents in Onitsha using a questionnaire. Averaged results of the physicochemical parameters showed that pH yielded 5.56, electrical conductivity yielded 0.2286µS/m, turbidity yielded 0.0058NTU, total dissolved solids yielded 54.28mg/l and total suspended solids yielded 35.3mg/l. In addition, averaged results of the heavy metal parameters showed that lead yielded 0.0108mg/l, cadmium yielded 0.0284mg/l, copper yielded 0.0386mg/l, iron yielded 2.15mg/l, zinc yielded 0.738mg/l, chromium yielded 0.0412mg/l and cobolt yielded 0.0902mg/l. Results of the microbiological parameters showed that for total count, Olek yielded 79 x 10^3MPN/100ml, Nation yielded 48 x 10^3MPN/100ml, De-beste yielded 19 x 10^4MPN/100ml, Jemok yielded 66 x 10^3MPN/100ml and Aqua-Rapha yielded 98 x 10^2MPN/100ml. The study recommended that the qualities of sachet water brands should be in line with NSDWQ standards with a view to raising standard in the industry and reassuring the public of the safety of these products for public consumption.

Keywords: analyses, microbiological, Onitsha, physicochemical, quality, sachet water.

INTRODUCTION

Water is an inseparable aspect of human life that determines the potential and possibilities of human activities in the environment such as personal hygiene, environmental sanitation and livelihood enhancement (Oluyemi, 2013). In fact, human activities and settlement hinge on the availability of water, including both our physical and biological environment. Surface water, which is about 0.02% of the total water composition, would have been enough for man's need if it were evenly distributed and kept clean. With this in mind, water quality therefore becomes one of the primary issues of concern to man (Aina *et al.*, 2012). Sustainable use of water resources aims at protecting and enhancing water quality while maintaining its social and economic development (Oluyemi, 2013). Megersa (2018) defined safe drinking water as the water that does not represent any significant risk to health over a lifetime of consumption. The safe drinking water must be delivered that is pure, wholesome, healthful and potable (Megersa, 2018).

In Nigeria, after almost sixty years of water supply development, it is regrettable that only sixty percent of the population has access to safe drinking water and in rural areas less than fifty percent of households have access to good potable water

(Gbadegesin and Olorunfemi, 2007). In Nigeria, availability of drinking water is an issue of great concern to localities depending on non-public water supply system such as water tankers and boreholes. The alternative use of these water sources has come to stay as a result of the inability of the State Water Corporation to supply water to all parts of Anambra State. Microbiological indicators are of interest because of its capacity to spread diseases within human populations. Nearly 90% of diarrhea-related cases and deaths have been attributed to unsafe drinking water and sanitation conditions (Agwu *et al.*, 2012). The essence of checking for potability is to reduce the potentiality of water in spreading diseases within susceptible human populations (Omezuruike *et al.*, 2008). Water-based diseases such as typhoid astronomically increased in Onitsha from 2009 to 2014 as reported by the Anambra State Ministry of Health (Anambra State Ministry of Health 2014). In view of this fact, there is a need to examine or analyse sachet water consumed by Onitsha residents with a view to determining its potability as well as the physicochemical, microbiological parameters in relation to standards such as the Nigerian Standard for Drinking Water Quality (NSDWQ).

Therefore, this study aimed to analyse the physicochemical and microbiological qualities of five sachet water brands that are mostly consumed in Onitsha North and Onitsha South local government areas (LGAs) of Anambra State, Nigeria. The study also selected the five sachet water brands that are mostly consumed in Onitsha using a questionnaire. The study availed information on the physicochemical and microbiological parameters that make sachet water unfit for consumption by the public which is useful to the relevant state and federal parastatals for enforcement and control.

MATERIALS AND METHODS

Study Area:

Onitsha is located between latitudes 6°10.6'N and 6°7.4'N and longitudes 6°48'E and 6°44'E in the Anambra North Senatorial Zone of Anambra State and is well-known for commercial activities. It occupies the eastern bank of the River Niger, covering some 50 square kilometres.

Sample Collection

The study was conducted between July 2016 and December 2016 in the low, medium and high densities' areas of both Onitsha North and Onitsha South LGAs. A total of five (5) sachet water brands were analyzed for physicochemical and microbiological parameters. One sample from each of the tested sachet water brands was selected for analyses. The selected five sachet water brands were elicited from respondents using a questionnaire. Responses were elicited from residents in Onitsha by adopting a purposive sampling method for the questionnaire distribution.

Physicochemical Analyses

The researchers used a Model PHS-25 pH meter to determine pH, a Model DDS-307 Conductivity Meter to measure the conductivity, a Hanna H1 99300 TDS Meter to measure the dissolved ions content of the five sachet water samples. A Buck Model 210 VGP atomic absorption spectrophotometer (AAS) to determine the concentrations of lead, cadmium, copper, iron, zinc, chromium and cobolt for the five sachet water brands (HACH, 2013).

Microbiological Analysis

The researchers used streak-plate method with Mac Conkey Broth agar for the determination of microbiological parameters. An Electron Microscope and JOUAN XMTD Incubator were also used in the microbiological analyses (HACH, 2013).

RESULTS

Table 1 below shows the pH, conductivity, turbidity and total solids contents for the five sachet water brands that are mostly consumed in Onitsha. Aqua-Rapha with the highest pH value is slightly acidic (pH = 6.3) while Olek with the least pH value is slightly acidic (pH=5.0). The highest conductivity was recorded with Jemok (0.340μS/m) while the lowest conductivity was recorded with De-beste (0.130μS/m). Turbidity was highest in De-beste sachet water (0.011NTU) and lowest in Nation sachet water (0.001NTU). Total Dissolved Solids was highest in Nation sachet water (94.8mg/L) and lowest in De-beste sachet water (16.3mg/L). Total Suspended Solids was highest in Nation sachet water (52.6mg/L) and lowest in De-beste sachet water (13.4mg/L).

Table 1: Physicochemical Parameters for Selected Sachet Water Brands in Onitsha

S/N	Brands	pH	EC (µS/m)	Turbidity (NTU)	TDS (mg/L)	TSS (mg/L)
1	Olek	5.0	0.153	0.01	56.1	28.5
2	Nation	5.6	0.250	0.001	94.8	52.6
3	De-beste	5.7	0.130	0.011	16.3	13.4
4	Jemok	5.2	0.340	0.004	63.8	44.8
5	Aqua-Rapha	6.3	0.270	0.003	40.4	37.2

Key: EC = electrical conductivity; TDS = total dissolved solids; TSS =total suspended solids; NTU = nephelometric turbidity units; µS/m = microsiemens per meter, mg/L = milligram per liter.

The heavy metal parameters of the five sachet water brands that are mostly consumed in Onitsha are given in Table 2 below. The range in value for lead heavy metal is between De-beste (0.018mg/L) and Aqua-Rapha (trace). Cadmium heavy metal peaked at Jemok (0.042mg/L) and was least in De-beste (0.009mg/L). The range in value for copper heavy metal is between Jemok (0.062mg/L) and De-beste (0.009mg/L). Iron heavy metal had its peak value in Nation sachet water (3.06mg/L) and was lowest in Jemok (0.93mg/L). The range in value for zinc is between Olek (1.7mg/L) and Aqua-Rapha (0.24mg/L). Chromium heavy metal had its peak value in Aqua-Rapha (0.080mg/L) and the least value in Jemok sachet water (0.021mg/L). The range in value for cobolt heavy metal is between Olek (1.140mg/L) and Jemok (1.00mg/L).

Table 2: Heavy Metals Parameters for Selected Sachet Water Brands in Onitsha

S/No	Brands	Lead (mg/L)	Cadmium (mg/L)	Copper (mg/L)	Iron (mg/L)	Zinc (mg/L)	Chromium (mg/L)	Cobolt (mg/L)
1	Olek	0.011	0.032	0.015	2.64	1.7	0.024	1.14
2	Nation	0.017	0.040	0.06	3.06	0.24	0.031	1.139
3	De-beste	0.018	0.009	0.009	2.39	0.31	0.05	1.132
4	Jemok	0.008	0.042	0.062	0.93	1.2	0.021	1.0
5	Aqua-Rapha	trace	0.019	0.047	1.73	0.24	0.08	1.04

The microbiological parameters of the five sachet water brands that are mostly consumed in Onitsha are given in Table 3. Total count/coliform (TC) bacteria were highest in De-beste sachet water (19 x 10^4MPN/100mL) and least in Aqua-Rapha sachet water (98 x 10^2MPN/100mL). The highest number of microbial isolates was recorded in Jemok (*Salmonella spp*, *Klebsiella spp*, *Escherichia coli*, *Pseudomonas aeruginosa*) while Aqua-Rapha sachet water had the least microbial isolate (*Streptococcus faecalis*).

Table 3: Microbiological Parameters of Selected Sachet Water Brands in Onitsha

S/No	Brands	Dilution Factor	Total Count (MPN/100ml)	Microbial Isolates
1	Olek	10^{-6}	79×10^3	*Klebsiella spp, Escherichia coli*
2	Nation	10^{-6}	48×10^3	*Streptococcus faecalis, Pseudomonas aeruginosa, Klebsiella spp*
3	De-beste	10^{-6}	19×10^4	*Klebsiella spp, Escherichia coli, Streptococcus faecalis*
4	Jemok	10^{-6}	66×10^3	*Salmonella spp, Klebsiella spp, Escherichia coli, Pseudomonas aeruginosa*
5	Aqua-Rapha	10^{-5}	98×10^2	*Streptococcus faecalis*

DISCUSSION

This study found out that 5.56units of pH was present in tested sachet water brands. This finding is similar to the work of Abdus-Salam *et al.* (2010) who assessed the physicochemical quality of water in oil producing areas of Ilaje, Nigeria and found out that 5.86units of pH was present in the water. The reason for this finding is that water contains two molecules of hydrogen ion which accounted for the slightly acidic nature of tested sachet water. Thus, the hydrogen ions were responsible for the slightly acidic nature of tested sachet water brands.

The study found out that 0.2286µS/m of electrical conductivity (EC) was present in tested sachet water brands. This finding is similar to the work of Ekhaise & Anyasi (2005) who studied the influence of breweries effluent discharge on the quality of Ikpoba River in Nigeria and found out that 0.1976µS/m of EC was present in the water. EC is a measure of free ions present in water and sachet water which contains only hydrogen and hydroxide ions is relatively low as indicated by the low EC value. Thus, the few hydrogen and hydroxide ions present in sachet water was accounted for the low conductivity.

The study found out that that 54.28mg/L of total dissolved solids (TDS) was present in tested sachet water brands. This finding is similar to the work of Cheabu and Ephraim (2014) that assessed the quality of sachet water in Obuasi, Ghana and found out that 54.0mg/L of TDS was present in the water. The low TDS value was accounted for by human activities associated with sachet water production process. Thus, dissolved solids from associated human activities are responsible for the relatively low TDS value. The study found out that 35.3mg/L of total suspended solids (TSS) was present in tested sachet water brands. This finding is similar to the work of Belay and Sahil (2013) that assessed the effect of brewery effluent on the quality of Shinta River in Ethiopia and found out that 42mg/L of TSS was present in the water. The TSS value was accounted for by human activities associated with sachet water production process. Thus, suspended solids from associated human activities were responsible for the relatively low TSS value.

In the heavy metal analyses, the study found out that 0.0386mg/L of copper was present in tested sachet water brands. This finding is similar to the work of Oluyemi (2013) who tested the quality of selected public wells in Ekiti State, Nigeria and found out that 0.05mg/L of copper was present in the water. The study found out that 2.15mg/L of iron was present in tested sachet water brands. The study found out that 0.738mg/L of zinc was present in tested sachet water brands. This finding is similar to the work of Olayinka (2010) who assessed the metal analyses of well water samples in Akure, Nigeria and found out that 1.02mg/L of zinc was present in the water. The study found out that 0.0284mg/L of cadmium was present in tested sachet water brands. This finding is similar to the work of Abdus-Salam *et al.* (2010) who assessed the physicochemical quality of water in oil producing areas of Ilaje, Nigeria and found out that 0.025mg/L of cadmium was present in the water. The study found out that 0.0108mg/L of lead was present in tested sachet water brands. This finding is similar to the work of kerketta *et al.* (2013) that analyzed the heavy metals in drinking water from different sources in Jharkhand, India and found out that 0.01mg/L of lead was present in the water. Presence of heavy metals in tested sachet water might were accounted for by contents which entrained from sachet water purification process. Thus heavy metal contents entraining from sachet water purification processes were responsible for the presence of heavy metals in tested sachet water brands.

In the microbiological analyses, the study found out that 79 x 10^3MPN/100mL of total count/coliform (TC) bacteria was present in Olek sachet water. This finding is similar to the work of Jimoh and Adesina (2012) who assessed the incidence of coliform in well water in Sabon-Gari, Nigeria and found out that 7.3 x 10^6 of TC bacteria was present in the water. The study found out that 48 x 10^3MPN/100mL of TC bacteria was present in Nation sachet water. The study found out that 19 x 10^4MPN/100mL of TC bacteria was present in De-beste sachet water. This is similar to the work of Anyamene and Ojiagu (2014) who studied the bacterial analyses of sachet water sold in Awka, Nigeria and found out that 20.1 x 10^4 MPN/100mL of TC bacteria was present in the water. The study found out that 66 x 10^3MPN/100mL of TC bacteria was present in Jemok sachet water. This finding is similar to the work of Akpomie *et al.*, (2015) who assessed the effect of brewery effluent on the microbiological quality of Ikpoba river in Benin City, Nigeria and found out that 60 x 10^3 MPN/100mL of TC bacteria was present in the water. The study found out that 98 x 10^2MPN/100mL of TC bacteria was present in Aqua-Rapha sachet water. The presence of TC bacteria and indicator organisms could be attributed to unsanitary environment of sachet water production process. Thus, unsanitary environment of sachet water production process is responsible for presence of total coliform bacteria and indicator organisms in tested sachet water.

There is presence of indicator organisms such as *Klebsiella spp* and *Pseudomonas aeruginosa* in the tested sachet water brands. Unsanitary conditions in sachet water production process are responsible for the presence of indicator organisms in sachet water. Thus, disease-causing microorganisms are responsible for the presence of indicator organisms in tested sachet water. *Pseudomonas aeruginosa* can cause infections in the blood, lungs while *Klebsiella spp* can cause pneumonia, sepsis, wound infections and urinary tract infections. Even more health-threatening is the presence of fecal indicators such as *Streptococcus faecalis* and *Escherichia coli*, which are major causes of diseases which are harmful to the human body. Fecal indicators are introduced into the environment (of which water is a part) through fecal matter as they are responsible for diseases such as diarrhea, fever and pains. *Salmonella typhi* which causes typhoid is present in the tested sachet water samples. This study postulated that the sachet water ingested by Onitsha inhabitants may be responsible for water-related diseases such as typhoid and the presence of *Salmonella spp* (which causes typhoid) in the selected sachet water brands confirm that.

CONCLUSION

In line with the objectives of this study, there is presence of pH, conductivity, turbidity and total solids contents which were not significant relative to their standard regulatory values in tested sachet water brands in Onitsha. Also, there is presence of heavy metals in tested sachet water whose bioaccumulation by people of Onitsha is unhealthy. From the study carried out, there is presence of indicator organisms in sachet water in Onitsha which is responsible for morbidity of diseases such as typhoid and diarrhea in susceptible human populations in Onitsha.

Recommendations

The following were recommended for this study:

i. Physicochemical and microbiological qualities of sachet water brands should be in line with NSDWQ standard.
ii. Sachet water vending machines should be properly disinfected to guard against

indicator organisms entraining into them which can serve as a source of sachet water contamination.

iii. Total coliform bacteria and indicator organisms should be hygienically removed from sachet water production processes.

iv. Sachet water regulatory agency (National Agency for Food Drug Administration and Control) should ensure that sachet water brands are produced in hygienically-sound environment.

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